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Development of Low Cost Weaning Foods from Locally Available Grains

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KEYWORDS Formulation. Germination. Infants. Nutrition. Roasting. Sensory

ABSTRACT Most children suffer from malnutrition. The factors responsible for this are generally ignorance of mothers, low-income, lack of education on the nutritional requirement and also lack of knowledge on the locally available sources of nutritionally rich food crops. Therefore, in the present study, the researchers aimed to develop low-cost nutritional value weaning mix based on locally available ingredients such as wheat, Bengal gram, groundnut and sugar in the proportion of 60:20:15:5 (g/100g). Germination and non-germination were two processing techniques used. The developed weaning mixes were evaluated for their sensory evaluation, proximate analysis and storage studies. Germinated weaning mix increased moisture (9%), protein (17.53%), and fibre content (1.91%) and also improved the sensory parameters. Moisture content and fat acidity of weaning mixes increased with increase in storage periods. The results showed that germinated weaning mixes could be used as good nutritional supplements for infants.

INTRODUCTION

Malnutrition is a remarkable global issue and it contributes to increased infant mortality rate, due to lack of access to nutritious foods and poor feeding practices and also offering wrong choice of foods, which fail to meet nutrients demand for children especially in rural areas (Berg 1967). Although breastfeeding is one of the excellent choices for feeding practice in the human infant, it provides nutrients required for growing infant for only up to six months. Thereafter it is inadequate to sustain optimal growth and development and there is a need to be complemented with other nutrients, such as weaning foods (Abeshu et al. 2016).

In India especially the most rural areas, the duration of breastfeeding ranges from 1 to 3 years, and there is a belief that as long as the child is fed with breast milk, other foods are not vital. Breast milk alone cannot sustain a suitable rate of growth beyond four to five months. Therefore, growth slows down unless additional food is provided (Devadas et al. 1984). Weaning is the process of gradually introducing an infant diet by processing the ingredients to make them easily digestible. Weaning foods are manufactured commercially by using roller drying or extrusion cooking which are still not reachable to the majority of the Indian population, especially in rural places (Gahlawat and Sehgal 1992). In rural places, women are also constrained for both money as well as time. So, it becomes vital to develop weaning foods from the locally available ingredients such as cereals, pulses, chickpea, split pea, red gram, green gram and finger millet.

Good quality weaning foods are rich in calories, high balanced-protein content, adequate vitamin and mineral contents, soft texture with low fibre content, and also when weaning mix stirred with water (cold or warm), it should form a uniform slurry or soft consistency, enabling the child to swallow it for easy digestion and also an absence of anti-nutritional factors. Moreover, they should be free from any other contaminated products and be unaffected to other changes for storing longer shelf life (Gahlawat and Sehgal 1994).

There are various food processing techniques such as roasting, germination, milling, baking, cooking, fermenting, which tend to increase the nutrient bioavailability, nutrient density, storage stability and palatability. Some of these processing techniques are applicable for use at the home

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level (Bressani et al. 1984). Germination has a higher impact on the nutritional content of grains such as legumes, cereal and pulses. Germination may be utilised to improve the nutritional value by hydrothermal treatment, which leads to structural modification and starts to synthesis new bioactive compounds, which enhance the nutritional content and stability of cereal, pulses and legumes by increasing nutrient bioavailability, easy for digestibility, reducing the levels of anti-nutritional compounds, increasing and improving the functionality of carbohydrate and protein contents, particularly free amino acids contents (Bibi et al. 2008; Malomo et al. 2012; Vidal et al. 2002).

Majority of children between the ages of six months to three years suffer from malnutrition. The factors responsible for this are generally lack of access to highly nutritious enriched foods, limited knowledge about nutrition or education, loss of appetite, low income or poverty, and also particularly in the current context of rising food cost/prices, which cause malnutrition. Thus, it is necessary to educate low income or poverty-stricken families to use locally produced foods (Gulzar 2011).

Objectives

The present study was aimed to develop a low-cost nutritional value weaning mix based on locally available ingredients such as wheat, Bengal gram, groundnut and sugar.

MATERIAL AND METHODS

Procurement of Samples

Wheat, Bengal gram, groundnut and sugar were procured from the local market in Kolar district, Karnataka. Wheat, Bengal gram, groundnut and sugar were thoroughly cleaned to remove dirt, dust, insect excreta or feathers and admixture of other food grains.

The raw ingredients of weaning foods were wheat, Bengal gram, groundnut and sugar. In the present study, germination and non-germination were two processing techniques used in the ratio of 60:20:15:5 (g/100g) of wheat, Bengal gram, groundnut and sugar, respectively.

Processing and Formulation of Germinated Weaning Food

Wheat and Bengal gram were washed separately soaked in potable water for 10 hours. The unimbibed water was drained out and soaked grains were tied in wet muslin cloth separately and allowed for 24 hours for germination at room temperature. After 24 hours, the germinated wheat and Bengal gram were rinsed with potable water and then dried at 55-60^{o} C. The dried samples of sprouted wheat, Bengal gram and ground nut were roasted separately under low flame (70-80^{o} C) to give a pleasant flavour and the roasted samples of wheat, Bengal gram (dehusked) and groundnut (dehusked) were ground to fine powder in an electric grinder to make fine flour and sieved by 80-100 mesh, and then stored in plastic containers for further use.

Processing and Formulation of Non-germinated Weaning Food

The clean graded wheat, Bengal gram and groundnuts were roasted separately under low flame (70-80^{o} C) to give a pleasant flavour and the roasted samples of wheat, Bengal gram (dehusked) and groundnut (dehusked) were ground to fine powder in an electric grinder to make fine flour and sieved by 80-100 mesh, and then stored in plastic containers for further use.

Development of Weaning Food Mixtures

Two types of weaning food mixtures were formulated using germinated flour and non-germinated in the ratio of 60:20:15:5 (g/100g) of wheat, Bengal gram, groundnut and sugar, respectively. Prepared weaning foods from germinated and non-germinated ingredients were subjected to screen sensory evaluations, proximate analysis as well as shelf-life studies.

Sensory Quality Characteristics of Germinated and Non-germinated Weaning Food Mixtures

The formulated weaning food mixtures were subjected to sensory analysis based on a 9-point hedonic scale as described by Larmond (1977), for colour, taste, texture, flavour and mouthfeel using an in-house trained panel of 5 members. Panel members were advised to use verbal descriptions

and convert them into scores. The scores were based on the following criteria: like extremely: 9, like moderately: 7-8, like slightly: 5-6, dislike slightly: 3-4, and dislike extremely: 0-2. The scores were averaged and rounded to the nearest whole number.

The Proximate Composition of Germinated and Non-germinated Weaning Food Mixtures

The crude fat, protein, moisture, ash, crude fibre contents and total carbohydrates were carried out by AOAC (2004). The crude fat was estimated by exhaustive extraction with petroleum ether using a Soxhlet apparatus (AOAC, 2004). The micro Kjeldahl method was used for the determination of protein (N × 6.25). The moisture, ash and crude fibre contents were determined by the AOAC (2004) methods. The total carbohydrate were obtained by difference of (100 – (% moisture + % crude protein + % crude fat + % ash).

Storage Studies of Germinated and Non-germinated Weaning Food Mixtures

The shelf-life studies of germinated and non-germinated weaning food mixtures were carried out in Polyethylene terephthalate (PET) jars for 45 days at ambient temperature. Each sample was packed in 100g and stored at ambient temperature for 45 days. All samples were drawn periodically after 0, 15, 30 and 45 days and moisture content and fatty acid acidity contents were analysed as an indicator of staleness. For free fatty acids, neutralised alcohol was added to the samples and against titration with 0.25 M NaOH until permanent faint pink colour appeared and persisted for more than 1 minute as described by AACC International (2000).

Statistical Analysis

Data was subjected to analyse statistically with the aid of the Statistical Analysis Software by using SPSS 16 software.

RESULTS AND DISCUSSION

Sensory Quality Characteristics of Germinated and Non-germinated Weaning Food Mixtures

Germination and non-germination were used to develop the weaning food mixtures in the ratio of 60:20:15:5 (g^{-1}100g) of wheat, Bengal gram, groundnut and sugar respectively, as shown in the Figures 1 and 2. The sensory quality parameters, namely, appearance, texture, flavour, taste, mouthfeel and overall acceptability of the weaning food mixtures values are listed in the Table 1. The sensory quality was calculated based on the mean score values of sensory parameters. Appearance is the first characteristic perceived by the human senses and plays a major role in the identification and final choice of food. Appearance is the visual perception of food comprising of colour, shape, size, gloss, dullness and transparency. The average scores for the appearance of a germinated mix (8.00±0.33) were significantly higher ($p \leq 0.05$) than the non-germinated mix (7.16±0.34). The texture is a vital parameter for the quality of food products that are decided by touch and feel and involves the degree of roughness or smoothness. The average scores for the texture of germinated mix (7.78±0.34) revealed that there is no significant difference ($p \leq 0.05$) when compared with the non-germinated mix (7.66±0.24).

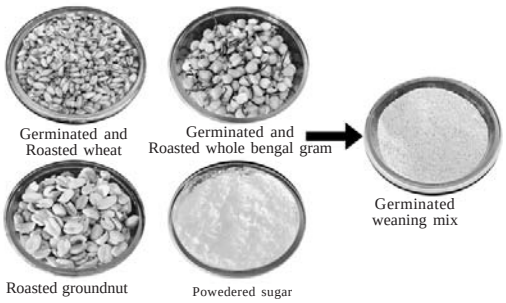

Fig. 1. Food ingredients for the development of germinated weaning mix

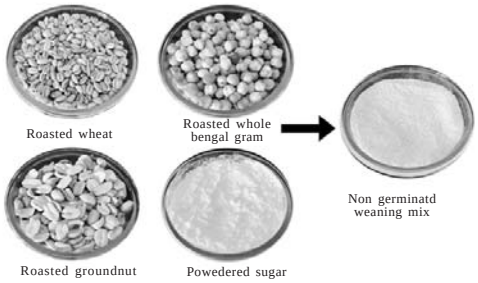

Fig. 2. Food ingredients for the development of non-germinated weaning mix

Table 1: Sensory evaluation of weaning food mixtures prepared from germinated and non-germinated grains

Weaning foods	*Appearance*	*Texture*	*Flavour*	*Taste*	*Mouth feel*	*Overall acceptability*
Germinated	8.0 ± 0.33[a]	7.78 ± 0.34[a]	8.0 ± 0.20[a]	8.0 ± 0.34[a]	7.8 ± 0.23[a]	8.0 ± 0.20[a]
Non-germinated	7.16 ± 0.34[b]	7.66 ± 0.25[a]	7.12 ± 0.19[b]	7.02 ± 0.08[b]	7.08 ± 0.17[b]	7.01 ± 0.18[b]

Values are mean ± SD of five independent determinations. Means not sharing a common superscript letter in a column are significantly different at ($P \leq 0.05$).

Flavour sensory phenomenon is used to denote the sensations of odour, taste and mouthfeel. Flavour includes both the aromas and tastes of food. Flavouring substances are aromatic compounds, which are conceived by the combination of taste and odour and perceived by the mouth and nose. Odour improves the delight of eating. The average scores for the flavour of the germinated mix (8.00±0.20) were significantly higher ($p \leq 0.05$) than the non-germinated mix (7.12±0.19). Taste is an important aspect for the sensory evaluation of the food. The product might be appealing and have high energy density but without good taste, such a product is likely to be unacceptable. The average scores for taste and mouthfeel of the germinated mix (8.00±0.34) and (7.8±0.23) were significantly higher ($p \leq 0.05$) than the non-germinated mix (7.02±0.08) and (7.01±0.18). The overall acceptability expresses how the panellists accept the product by considering all the other parameters of sensory evaluation. In the present study the germinated mix scored the highest values (8.00±0.20) for overall acceptability than a non-germinated mix (7.01±0.18). This observation can be explained due to the germination of wheat and Bengal gram, which greatly increases the simple sugar content and gave a pleasant sweet flavour note and this could be attributed to enhancing the sensory properties of the germinated weaning mix. The results were in agreement with Bellaio et al. (2013) stating that germination is a natural and traditional method that can be used to increase or enhance the nutritional and sensory attributes of grains like pulses, cereals and legumes.

The Proximate Composition of Germinated and Non-germinated Weaning Food Mixtures

The chemical compositions of germinated and non-germinated weaning food mixtures are shown in Table 2. Analysis of variance showed that there was a significant difference in the moisture content, carbohydrates, protein, fat and crude fibre content between germinated and non-germinated weaning food mixtures. The mean scores for moisture content of germinated mix (9.00%) were significantly higher ($p \leq 0.05$) than non-germinated mix (7.16%). It has been reported that during the early stage of the germination, legumes or cereals uptake the water from the surrounding and it undergoes many biochemical changes and metabolic processes such as hydrolysis, macromolecules biosynthesis, respiration, subcellular structures, and cell elongation. Hence, in this study moisture content was more in the germinated mix due to the uptake of water during the germination process. This finding is similar to Khatoon et al. (2006) and Nonogaki et al. (2010), as germination proceeds, legumes took up water from the surrounding for the metabolic process to initiate.

The protein content of germinated mix was significantly ($p \leq 0.05$) higher than that of the non-germinated mix. The increase in proteins may be

Table 2: The proximate composition of germinated and non-germinated weaning food mixtures

Weaning foods	*Moisture (%)*	*Carbohydrate (%)*	*Protein (%)*	*Fat (%)*	*Fibre (%)*
Germinated	9.0[a]	61.94[a]	17.53[a]	8.09[a]	1.91[a]
Non-germinated	7.16[b]	71.92[b]	15.45[b]	10.02[b]	0.81[b]

Values not sharing a common superscript letter in a column are significantly different at ($P \leq 0.05$).

due to loss of some carbohydrates and fats, which are utilised during respiration and also some amino acids are synthesised during germination. This observation agrees with other scientific findings that processing techniques such as germination and roasting improved the protein content of the food products (Jan et al. 2017; Ongol et al. 2013).

In the germinated mix the content of carbohydrates was significantly ($p \leq 0.05$) lesser than that of the non-germinate mix. This result can be explained, as during the germination process the activation of α-anaylase will take place, which leads to hydrolysis of carbohydrates, which results in a decrease in starch and increase in simple sugars in a time-dependent manner. The results corroborate with Kavitha and Parimalavalli (2014), which showed that in cereal and legume carbohydrate was used as a chief source of energy for sprouting growth and development, which resulted in a decrease in carbohydrate content after germination.

The fat value of the germinated mix was significantly ($p \leq 0.05$) lesser than that of non-germinate. This is due to increased activity of lipase enzyme in the germinated mix leading to decrease in the fat content. Similar results occurred in many studies where the fat value was found to be decreased in the germinated seed, the utilisation of fats as a main source of carbon for seed growth and also suggested that fatty acids are oxidised to carbon dioxide and water to generate energy for germination (Jan et al. 2017; Moongngarm et al. 2010).

Storage Studies of Germinated and Non-germinated Weaning Mix

The alterations in lipid profile during storage were followed by determining fat acidity values. The germinated weaning mix had significantly ($p < 0.05$) higher fat acidity values than that of the non-germinated weaning mix. The fat acidity of fresh germinated and non-germinated weaning mix is 15.30 and 13.80 mg KOH/100g respectively, while in stored ones of germinated and non-germinated weaning mix it varied from 15.30 to 19.13 mg KOH/100g and 13.80 to 17.13 mg KOH/100g respectively on the 45th day as shown in Table 3. From both the weaning mixes (germinated and

Table 3: Effect of storage studies on moisture content and free fatty acid values of germinated and non- germinated weaning mixtures.

	Moisture content (%)				*Free fatty acid value (mg of KOH kg^{-1} of fat)*			
	Storage intervals in PET jar				*Storage intervals in PET jar*			
Weaning foods	*0 day*	*15 days*	*30 days*	*45 days*	*0 day*	*15 days*	*30 days*	*45 days*
Germinated	9.0±0.03^{a*}	9.82±0.03^{b*}	11.0±0.05^{c*}	12.5.0±0.02^{d*}	15.30±0.23^{a*}	16.81±0.38^{b*}	17.91±0.19^{c*}	19.13±0.13^{d*}
Non-germinated	7.16±0.04^{a}	8.66±0.02^{b}	9.16±0.04^{c}	10.98±0.04^{d}	13.80±0.14^{a}	14.23±0.44^{b}	15.81±0.14^{c}	17.13±0.14^{d}

Values are mean ± SD of triplicate. Means not sharing a common superscript letter in a row are significantly different at (P d" 0.05).* significantly different at ($P \leq 0.05$) between germinated and non-germinated.

non-germinated) the researchers observed there was an increasing trend of moisture value with a progressive increase of storage period, and this may be one of the reasons for the increase in acidity during the 45 days of storage. This finding is similar to the results reported by Gopaldas et al. (1982), which showed that there was increase in fat acidity value of malted weaning foods than roasted containing wheat, Bengal gram and groundnut during storage for 28 days.

CONCLUSION

Two nutritive weaning mixes were prepared in the laboratory using economically feasible foodstuff ingredients from locally available markets. From this study, the researchers concluded that the germinated processing technique affects the nutritional content of the weaning mix. Germinated weaning mix increased moisture, protein and fibre content, and also improved the sensory parameters. Therefore, germinated cereals, pulses, and legumes are potential sources for the development of low-cost weaning food for low economic status group families.

RECOMMENDATIONS

This study recommends for the exploitation of locally grown food crops for the development of low-cost hygienic weaning foods. By applying the germination processing technique, the food stuffs (cereals, pulses and legumes), which gains several desirable characteristics, such as nutritional enrichment, elimination of anti-nutrients, prolonged shelf life, unique taste, easily digestible and stability could make them effective in solving some of the nutrition problems facing infants and children.

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